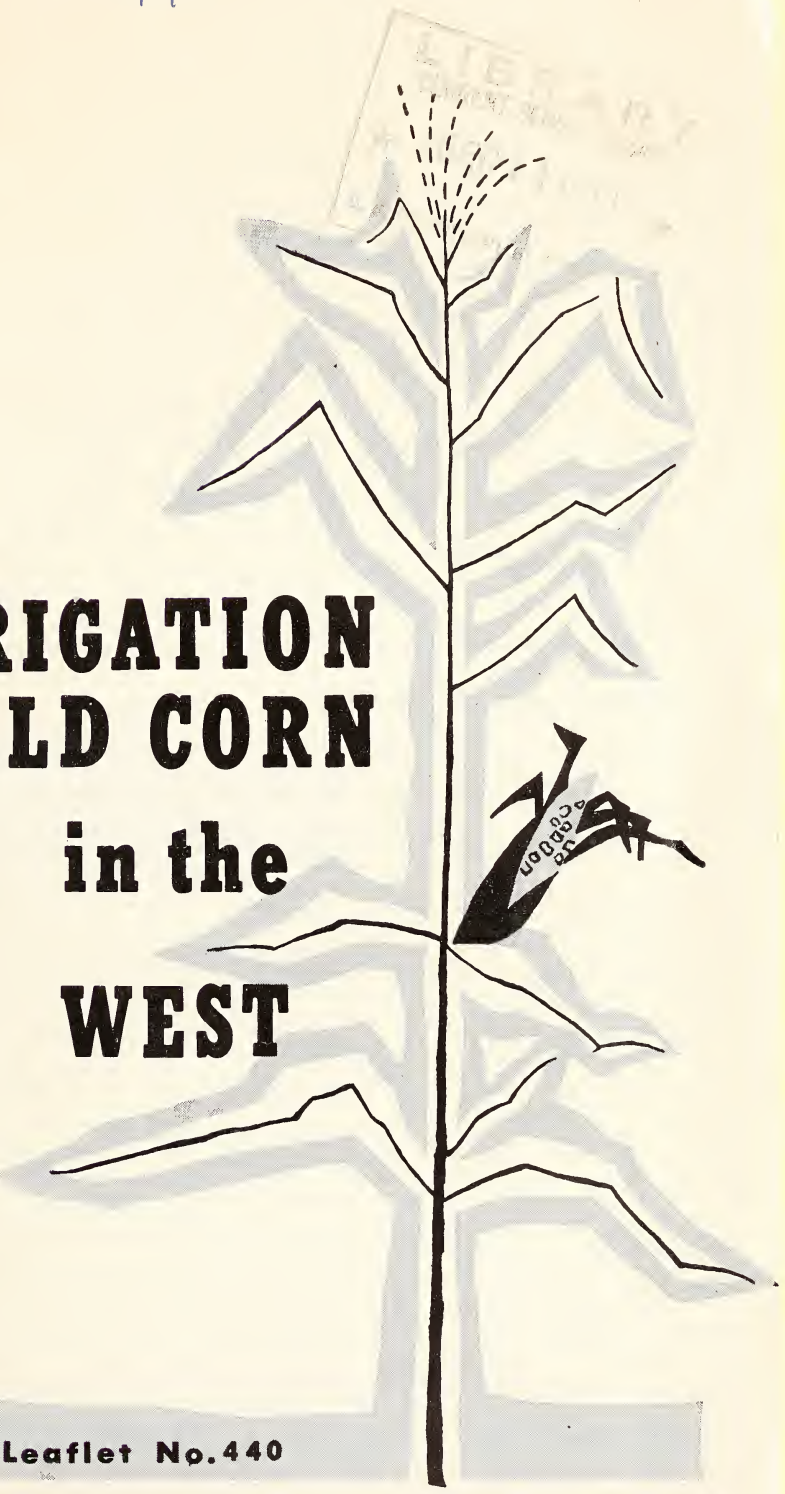
IRRIGATION of FIELD CORN in the WEST



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U. S. DEPARTMENT OF AGRICULTURE

Irrigation of field corn has been practiced for many years in arid and semiarid regions. It helps farmers grow corn on land that would otherwise be unproductive. In fact, proper irrigation in these regions contributes as much to high corn yields as proper selection of adapted varieties or adequate fertilization.

Several factors should be considered when corn is irrigated. Their proper application enables farmers to irrigate wisely and without wasting water.

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IRRIGATION OF FIELD CORN IN THE WEST

By J. S. Robins and H. F. Rhoades, *Soil and Water Conservation Research Division, Agricultural Research Service*

WATER USE BY CORN

How much water a corn crop uses depends on climatic conditions and length of the growing season. In general, corn uses more water in hot, dry, windy areas than in areas with less severe climates. The amount used in a season ordinarily is 16 to 25 inches, although amounts up to 33 inches and as low as 12 inches have been reported.

The rate at which water is consumed is as important as the total amount consumed. This rate largely determines the frequency of irrigation required to maintain satisfactory plant growth. As with total amount used, it varies with climate. But an additional factor is the stage of plant development. The rate is low when plants are small. It gradually increases to about silking, and gradually decreases as the plants mature. Rates seldom exceed 0.10 inch per day until corn is 8 to 12 inches high. The rate then gradually increases to 0.25 to 0.30 inch per day during the period of growth from silking to the soft dough stage. Following the soft dough stage, water use may continue at a high rate if the weather is hot and dry but will decline gradually as the weather becomes cooler and the plants mature.

During July and August the highest rate of use coincides with the most severe weather. It is necessary to design an irrigation system that will meet these peak rates. For short intervals the rate may be as high as 0.40 inch per day.

GROWTH AND SOIL MOISTURE

Growth and yield of corn may be seriously affected by deficient soil moisture, especially at certain stages of growth. Leaf curling or wilting (fig. 1) at any stage of growth reduces the growth rate. If prolonged or intense wilting occurs, "firing" of the leaves (fig. 2) may occur and yields may be seriously reduced.

These signs of moisture deficiency are related to (1) soil moisture condition, (2) climatic conditions, and (3) root development. Normally, little evidence of moisture deficiency will occur as long as some available water remains in the part of the soil profile that has been thoroughly explored by roots. Although this zone extends to a depth of 5 or 6 feet in deep, permeable soils by silking time, it is confined to much shallower depths earlier in the growing season.

As water is removed from soil, the forces that hold the remaining water

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Figure 1.—Wilted and normal corn. Corn on left received one irrigation following preplanting irrigation. Corn on right received only preplanting irrigation.

become greater. Thus, it becomes increasingly difficult for plant roots to extract water as the soil dries out. In addition, the rate of water movement from the soil to the root surfaces slows down as the soil dries.

The degree of dryness of the soil at which the rate of supply to the plant becomes too slow to prevent wilting varies from one soil to another. Fine-textured (clay) soils usually reach this state with more plant-available water than do sandy or coarse-textured soils. This is because clay soils retain a greater proportion of plant-available water in a condition requiring considerable force of removal than coarser-textured soils. Therefore, a smaller percentage of the total available water can be removed from clays than from sands without wilting of the plants or reductions in growth.

Severe climatic conditions may cause wilting of corn plants, even when soil moisture is relatively high. Wilting occurs because the soil fails to supply water as rapidly as the plant uses it. Therefore, the increased rate of water use results in wilting of the crop at a higher soil-moisture content than would occur when the rate was lower.

Root development greatly affects the supply of water that the plant can exploit. If roots are shallow and the soil incompletely explored, wilting will occur at a higher moisture content than if root development is good.

Development of the corn root system is progressive (fig. 3). In well-drained, deep soils, corn roots thoroughly explore the upper 4 feet of soil by silking time and enough roots will be in the fifth- and sixth-foot depths to extract some water. When seedlings emerge, however, roots have a maximum length of 6 to 8 inches and extend horizontally only about 4 to 6 inches. At the 8- to 10-inch height, numerous roots extend beyond 2 feet,

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Figure 2.—"Firing" of leaves because of severe moisture stress during midsummer.

but only the first foot is completely explored. Thus, the soil-moisture reservoir from which the plant can extract water is limited to a similar depth. Roots progressively increase in depth and number until about silking time and thus gradually contact additional water sources.

Root development of corn may be limited by poor physical conditions such as hardpans or plowpans, by poor aeration due to saturation of the subsoil or to extremely heavy clay subsoils, or by excessive accumulation of salts or toxic materials in the profile. Root pruning by cultivating equipment frequently destroys parts of the root system. This may be particularly serious since cultivation usually occurs when the root system is confined to relatively shallow depths.

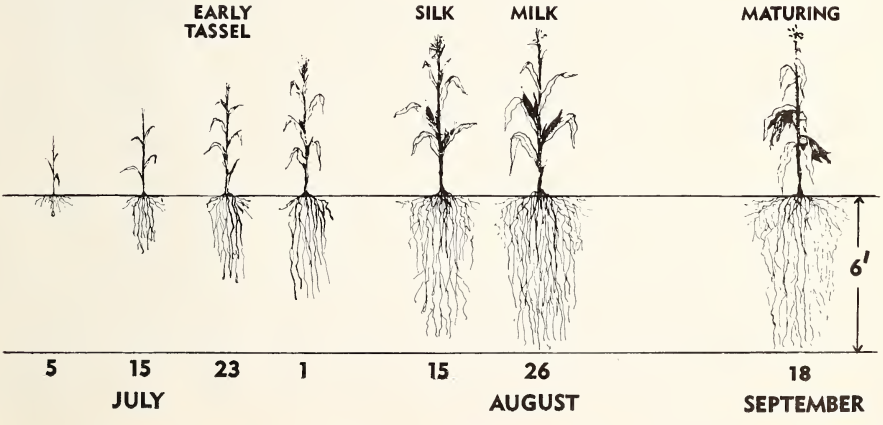

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Figure 3.—Root development of corn.

IRRIGATION REQUIREMENTS

The quantity of water in the soil that corn plants can extract and the rate of plant use determine how much and how often irrigation water should be applied to maintain rapid plant growth.

How much water a given soil holds depends on its texture (size of the soil particles—coarse, medium, or fine) and its depth; for example:

Coarse-textured (sandy) soils hold 0.75 to 1.25 inches of water for each foot-depth of soil.

Medium-textured soils (loams) hold 1.25 to 1.75 inches of water for each foot-depth of soil.

Fine-textured soils (clays) hold 1.75 to 2.25 inches of water for each foot-depth of soil.

These values also indicate how much irrigation water per foot of soil is required at any irrigation to replace the water removed by the crop.

Thus, each foot-depth of the different soil types retains enough water to sustain the crop for approximately the following number of days in the absence of rainfall:

Water use per day	*Sandy soils*	*Loams*	*Clays*
Corn, 8–12 inches high; 0.10 inches	7 to 12	12 to 17	17 to 22
Corn, silking; 0.25 inch	3 to 5	5 to 7	7 to 9

These data are for a foot-depth of soil. Each additional foot-depth of soil adds a given quantity to the soil moisture storage capacity. However, a further consideration in determining how often to irrigate and how much water to apply is the rooting habits of the crop. As previously stated, corn roots thoroughly explore the upper 4 feet of soil by silking time and some roots extract water from the fifth- and sixth-foot depths. Thus, from silking to maturity a soil depth of 4 feet may be considered as the storage reservoir if soil conditions are favorable. Of course, if soil depth is less than 4 feet or if serious hardpans or coarse sand or gravel layers are encountered, the depth considered must be modified.

Before silking, the corn root system gradually develops from the time the seed germinates until tasseling. Therefore, from emergence until silking, the effective moisture storage reservoir is expanding and this must be considered in determining how often to irrigate and how much water to apply.

To determine when and how much to irrigate, the corn producer then must carefully consider the following points:

1. How much water the soil retains both with respect to its moisture-holding capacity and to its depth.

2. How fast the crop is using moisture from the soil with respect to climatic conditions and to stage of plant growth.

3. How extensive the corn root system is as affected by stage of plant growth and by any unfavorable soil conditions that may limit root development. This factor will determine how much of the soil profile

to consider as a reservoir for the crop.

For example, consider corn growing on a fine sandy loam (medium-textured) soil. The soil is 6 feet deep. The climate is severe. The corn is tasseling. It hasn't been irrigated for 16 days. At the time of the last irrigation, the corn was knee-high, and enough water was applied to fill the soil reservoir. The corn roots have explored about 3.5 feet of the soil.

Fine sandy loams hold about 1.5 inches of water for each foot-depth of soil. The storage reservoir is therefore about 5.25 inches (3.5 multiplied by 1.5). Assume that the corn is using 0.25 inch of water per day. During the 16-day interval, it has removed 4.0 inches of water leaving 1.25 inches of water in the soil. Another irrigation is now needed and 4.0 inches of water should be applied.

After this 4-inch irrigation, assume that the corn would use 0.30 inch of water per day and that the corn roots would explore another 0.5 foot of soil. The 4 inches of water applied would suffice for 15 days, after which a 4.5-inch irrigation would be needed.

In less severe climates, the corn might use but 0.20 inch of water per day before tasseling and 0.25 inch of water per day after tasseling. This rate of use permits smaller applications of water (3.2 and 3.75 inches) or an extended interval between irrigations.

The number of irrigations required may be as many as 10 on extremely sandy soils in arid climates.

IRRIGATION AND PLANT DEVELOPMENT

Adequate moisture to prevent wilting of the corn plant is essential throughout the growing season for production of high yields. However, certain growth periods are particularly important if severe reductions in yield are to be avoided.

The tasseling-to-silking stage is critical. In this short time, formation of the grain is initiated. If moisture is lacking during this time, pollination is incomplete and poorly filled ears result. An adequate irrigation at tasseling time is therefore essential. (Corn planted in shallow or sandy soil usually needs a second irrigation 5 to 10 days later.) Since this is the period of highest rate of water use, special care must be exercised in avoiding severe wilting. Severe wilting for 2 days at this time has reduced yields more than 20 percent.

Depletion of the available soil moisture after silking and before maturity also reduces the grain yield if further water is not supplied. The yield will be reduced in proportion to the length of time that the plants are without appreciable amounts of water. After the grain is mature (hard-dough stage), neither yield nor moisture content of the grain is affected by lack of available water.

Vegetative growth is greatly affected by lack of moisture before

Figure 4.—Dwarfing of corn because of moisture deficiency before tasseling. Corn on left received 1 irrigation after planting; corn on right received 3 irrigations. (Courtesy of Farm Journal.)

tasseling (fig. 4). Later deficiencies have little effect on the height of the plants or on forage yields.

One further important point is the desirability of having the soil reservoir filled with water at planting time. Preplanting irrigations are usually needed. This insures adequate subsoil moisture reserves for the crop to draw on. It greatly lessens the hazard of not getting an irrigation applied before the crop removes all the available water. The crop can draw on this reserve and sustain itself for a considerable time without severe damage.

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